Republic of Iraq
Ministry of Higher Education & Scientific research
Al-Mustaqbal University
Science College
Biochemistry Department

Inorganic Chemistry

For

First Year Student/course 2

Lecture 1

By

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Structure of the atom

If organic chemistry is considered to be the chemistry of carbon, then inorganic chemistry is the chemistry of all elements except carbon. In its broadest sense, this is true, but of course there are overlaps between branches of chemistry.

What is the nature of the energy emitted by materials?

The nature of the energy emitted by materials was one of the issues that scientists were interested in:

1- In the 18th century, scientists accepted Newton's theory, which considered visible light to be composed of tiny particles.

2- In the early 19th century, Thomas Young published scientific results that supported the wave theory of visible light (which classifies visible light as a wave rather than a straight-line motion).

3- At the end of the 19th century, scientist Röntgen discovered X-rays, Becquerel discovered the phenomenon of radioactivity, and Thomson discovered the electron. It then became clear that the wave theory of light was insufficient to explain certain experimental results, most notably the phenomenon of black body radiation.

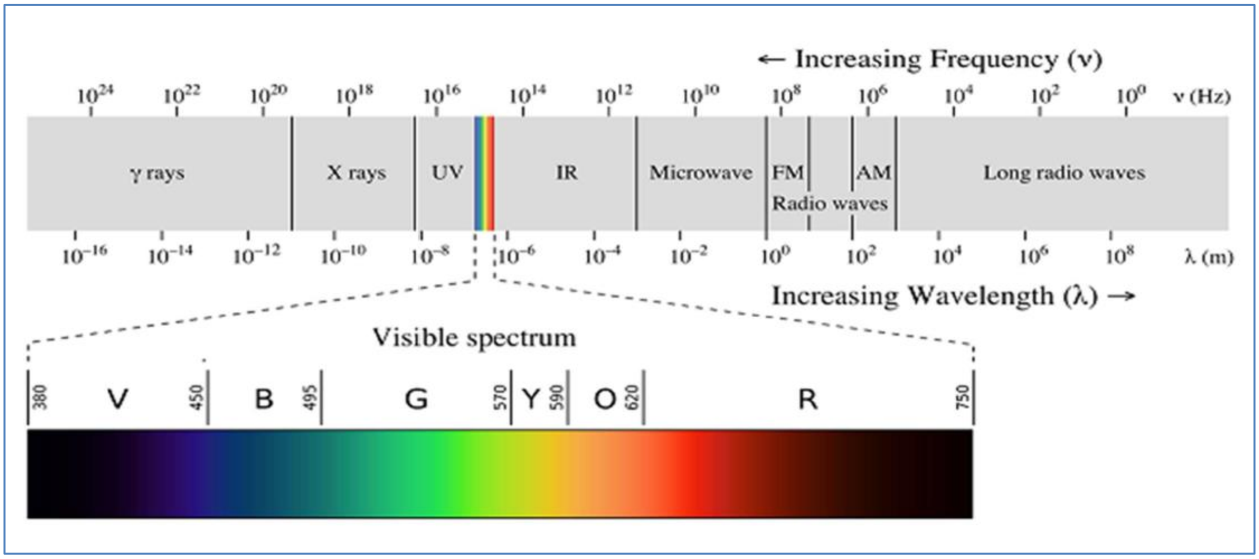
Origin of Quantum Theory

There are several phenomena and properties that led to the emergence of quantum theory, the most important of which are:

1) Electromagnetic Radiation Phenomenon

Electromagnetic radiation is a form of energy characterized by its wave nature and its ability to travel through a vacuum at an extremely high speed. Unlike some wave phenomena, such as sound, it does not require a medium for transmission but can propagate easily through empty space.

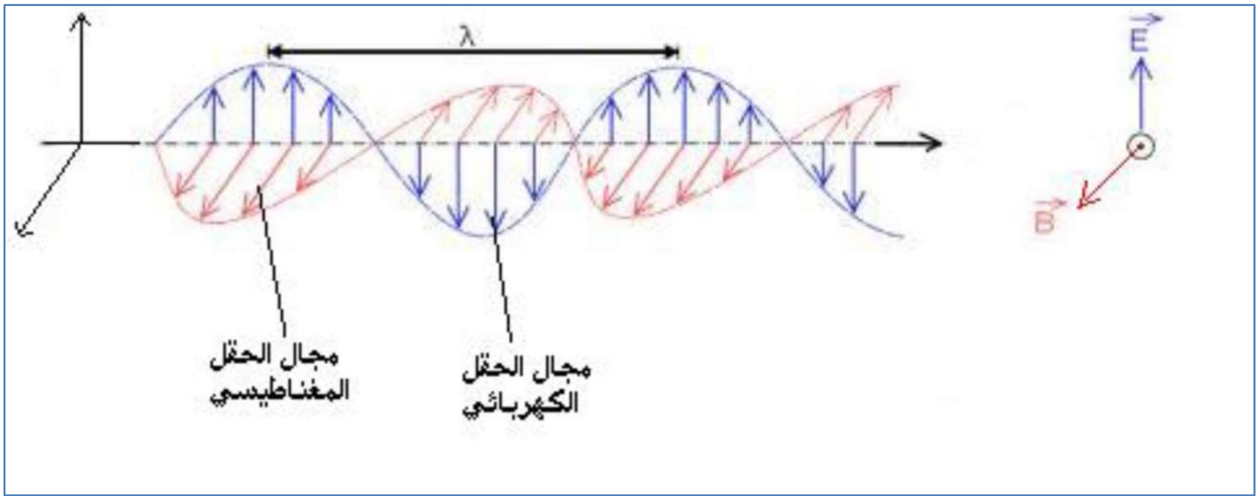
The **electromagnetic spectrum** covers a wide range of wavelengths, as shown below:



Electromagnetic Radiation

Light is a form of radiation resulting from the interaction of an electric field with a magnetic field, propagating as a wave motion through space. It travels at a constant speed in a vacuum, which is approximately:

$$C=3\times10^{8}m/s$$



Frequency and Wavelength

- **Frequency (f)**: It is the number of oscillations (vibrations) per second. The frequency does not depend on the nature of the medium through which the wave travels. It is measured in **Hertz (Hz)**.
- **Wavelength (λ\lambda)**: It is the linear distance between two identical points on consecutive waves, such as from crest to crest or trough to trough. It is usually measured in **meters (m)**.
- The relationship between wavelength and frequency is inverse. As the wavelength increases, the frequency decreases, and vice versa.

Name of the Spectrum	Wavelength	Frequency
Radio waves	100 Mm – 1 m	3 Hz – 300 MHz
Microwaves	1 m – 1 mm	300 MHz – 300 GHz
Infrared Radiation	1 mm – 750 nm	300 GHz – 400 THz
Visible Light	750 nm – 400 nm	400 THz – 800 THz
Ultraviolet Radiation	400 nm – 1 nm	10^{15} Hz – 10^{17} Hz
X-Rays	1 nm – 1 pm	10^{17} Hz – 10^{20} Hz
Gamma Rays	1 pm – 0.0001 pm	10^{20} Hz – 10^{24} Hz

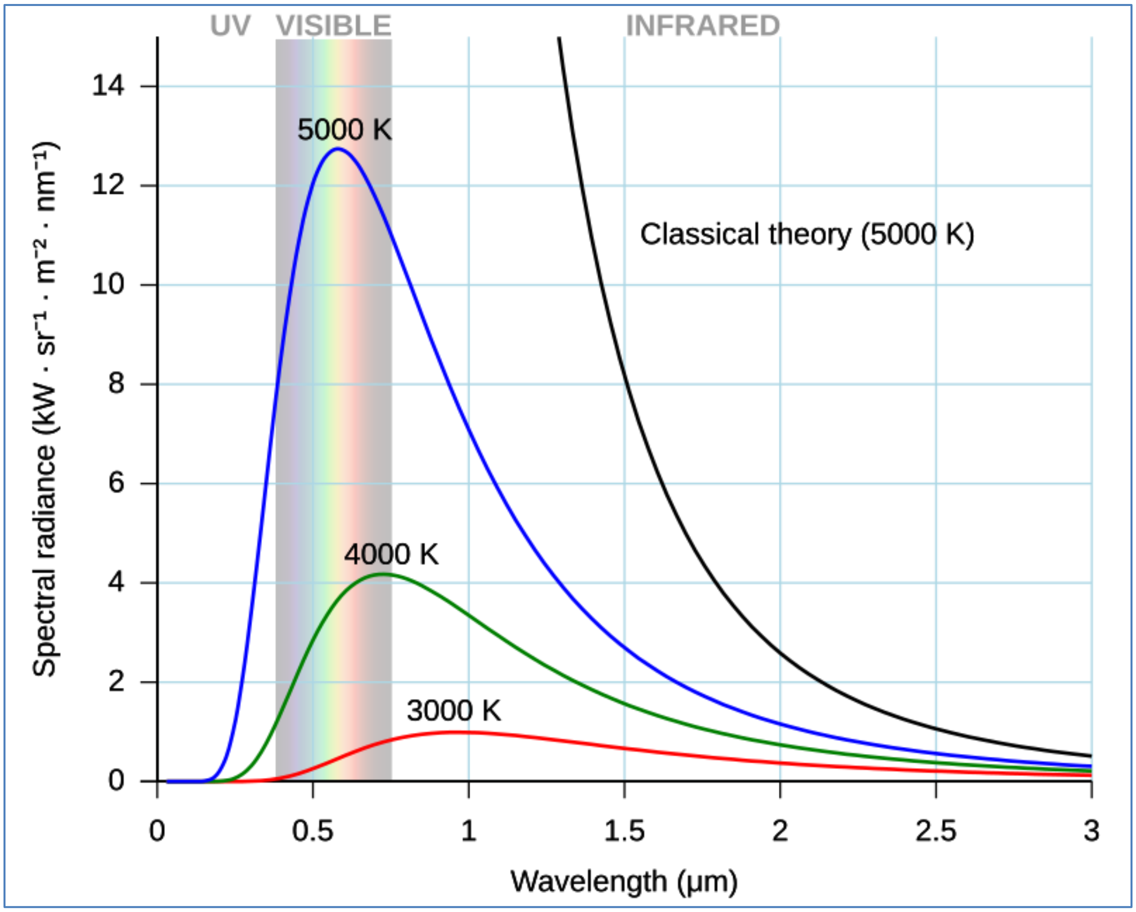
2) Black Body Radiation

1- When an object is heated, for example, a small piece of iron, it emits visible radiation. Initially, it glows red, then orange, yellow, and eventually white as it becomes hotter. Even at lower temperatures, it emits thermal radiation, such as infrared rays.

2- The term **black body radiation** refers to this emitted radiation, as it consists of photons that are emitted due to the thermal excitation of atoms, not because of the reflection of light from the surrounding medium. A **black body** is an idealized object that absorbs all incoming radiation and does not reflect any light. Hence, it is called **black body radiation**.

3- The emitted energy from a hot object consists of a continuous spectrum, where the properties such as frequency and wavelength change with the temperature. The energy of the emitted radiation increases as the temperature rises. In other words, as the temperature increases, the frequencies of the emitted radiation shift to higher values.

4- This phenomenon was observed by the scientist **Wien**, who formulated a law known as **Wien's Displacement Law**. According to this law, when the temperature of an object, like a piece of iron, increases, its color shifts from red to orange, then to yellow, and finally to white. As the temperature increases, the energy of the emitted radiation also increases.



Quantum Theory

In 1900, **Max Planck** proposed that energy is not emitted or absorbed continuously as classical theories suggested, but rather in **discrete packets** or **quanta**. This became known as **Quantum Theory**.

Planck hypothesized that the energy of emitted or absorbed light is proportional to its frequency (ν\nuν) and can be expressed by the equation:

$$E=h\nu$$

Where:

- E is the energy of the radiation,

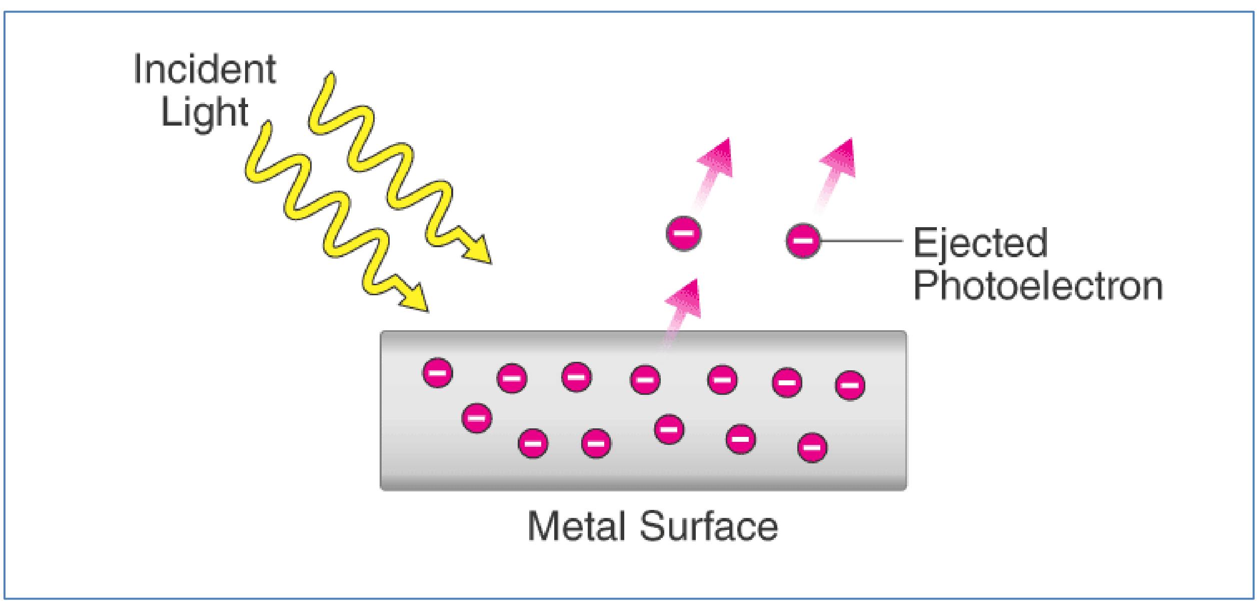
- h is **Planck's constant** (h=6.62×10−27 erg·second
- ν (pronounced "nu") is the frequency of the radiation.

This theory was not an extension of previous theories but a **radical change** in the concepts of the time. It successfully explained the shape of the radiation curve mentioned earlier, which could not be explained by classical physics.

Photoelectric effect

1- Photoelectric Effect: It is the **phenomenon** of the emission of electrons from the surface of a metal when light of a specific frequency falls on the metal's surface.

2-In 1887, the scientist **Heinrich Hertz** observed that when ultraviolet light falls on the surface of a metal, such as cesium, potassium, or sodium, the metal acquires a positive charge. This is due to the loss of electrons from the metal's surface as a result of the ultraviolet light's effect. This phenomenon is now known as the **photoelectric effect**.



Practical Results of the Photoelectric Effect:

1. The energy of the emitted electrons does not depend on the intensity of the incident light.
2. The number of emitted electrons is directly proportional to the intensity of the incident light.
3. The energy of the emitted electrons is directly proportional to the frequency of the incident light.
4. If the frequency of the light is below a certain value (which varies with the metal), no electrons are emitted from the metal surface.